zirconium isopropoxide (8 g), water (1 g), glycerol (1 g) and poly(ethylene gylcol) (1 g). Ten layers were deposited on a silicon substrate by spin coating and fired at 600° C. between each coating. The film was then heated overnight at 600° C. The resulting films were adherent and SEM analysis showed them to be dense and approximately 12 μm in thickness.

## EXAMPLE 13

### Silicon Carbide/Titanium Nitride Layered Composite

A silicon carbide paint and titanium nitride paint were prepared as in Examples 11 and 12 respectively. Alternating layers were applied by spin coating and fired at 600° C. between each coating. The film was then heated overnight at 600° C. The resulting films were adherent and SEM analysis showed them to be dense and approximately 12 μm in thickness.

We claim:

**1**. A process for producing a polycrystalline ceramic film on a substrate comprising:

(a) mixing a [organo-metallic] sol-gel solution with up to about 90% by weight of said solution of a ceramic powder *selected from the group consisting of oxides, carbides and nitrides* so as to produce a uniform stable dispersion;

(b) applying said stable dispersion to a substrate, *without a substantial temperature differential therebetween,* so as to provide a coating thereon up to about 6 μm thick; and

(c) firing said coated substrate at a temperature up to about 1000° C. so as to remove organic constituents and produce a stable polycrystalline [metallic oxide] *ceramic* film containing said ceramic powder on said substrate.

**2**. A process as claimed in claim **1** wherein steps (b) and (c) are repeated at least five times so as to produce a stable [crack-free] polycrystalline film at least 10 μm thick.

**3**. A process as claimed in claim **1** including the step of heating said [metallic oxide] *ceramic* film on said substrate at a temperature up to about 1000° C. after said firing.

**4**. A process as claimed in claim **1** wherein said ceramic powder is selected from the group consisting of *yttria* stabilized [Zirconia] *zirconia, ceria*, stabilized [Zirconia] *zirconia*, PZT, [Alumina] *alumina*, [Titania] *titania*, [Calcium] *calcium*, [Zirconate] *zirconate*, [Silica] *silica*, [Silicon Carbide] *silicon carbide*, [Titanium Nitride] *titanium nitride*, [Calcium-Hydroxyapatite,] and [Nickel Zinc Ferrite] *nickel zinc ferrite*.

**5**. A process as claimed in claim **4** wherein said sol-gel solution is selected from the group consisting of PZT, [Zirconia] *zirconia*, [Alumina] *alumina*, [Silica] *silica*, [Nickel Zinc Ferrite] *nickel zinc ferrite* and [Titania] *titania* solutions.

**6**. A process as claimed in claim **1** wherein said film is selected from the group consisting of a[,] bio-inert film[,] and a dielectric film.

**7**. A process as claimed in claim **6** wherein said bio-inert film comprises calcium zirconate.

**8**. A process as claimed in claim **6** wherein said dielectric film is selected from the group consisting of alumina, calcium-modified zirconia[,], and ceria stabilized zirconia.

**9**. A process as claimed in claim **1** wherein said substrate is selected from the group consisting of stainless steel and carbon steel nuts, carbon steel tubes, carbon steel plates, and aluminum substrates.

**10**. A process as claimed in claim **9** wherein said substrate is a carbon steel tube and said film is deposited on inside and outside surfaces thereof.

[**11**. A process as claimed in claim **1** wherein said film is crack-free.]

**12**. A process for producing a polycrystalline film selected from the group consisting of zirconia and titania on a substrate selected from the group consisting of aluminum foil and stainless steel, comprising:

(a) mixing a sol-gel mixture selected from the group consisting of titania and zirconia and a solution of a metal salt with up to 90% by weight of a [yttria stabilized] powder selected from the group consisting of titania and *yttria stabilized* zirconia in a size range between 0.1 and 10 microns so as to produce a stable dispersion;

(b) applying said stable dispersion to said substrate so as to provide a coating up to 6 μm thick; and

(c) firing said coated substrate at a temperature up to about 500° C. so as to produce a stable polycrystalline film on said substrate.

[**13**. A process as claimed in claim **12** wherein said film is crack-free.]

**14**. A process for producing *a* polycrystalline composite ceramic [films] *film* on a substrate comprising:

(a) mixing a first [organo-metallic] sol-gel solution with up to about 90% by weight of *said first solution of* a first ceramic powder so as to produce a first uniform stable dispersion;

(b) mixing a second [organo-metallic] sol-gel solution with up to about 90% by weight of said *second* solution of a second ceramic powder so as to produce a second uniform stable dispersion;

(c) applying a first coating of one of said first and second stable dispersions to said substrate, *without a substantial temperature differential therebetween*;

(d) firing said first coating at a temperature up to about 1000° C. so as to remove organic constituents and produce a stable polycrystalline first [metal oxide] *ceramic* film containing a respective one of said ceramic powders on said substrate;

(e) applying a second coating of the other of said first and second stable dispersions to said first [oxide] *ceramic* film on said substrate; and

(f) firing said second coating at a temperature up to about 1000° C. so as to remove organic constituents and produce a stable [crack-free] polycrystalline second [metal oxide] *ceramic* film containing the respective other one of said ceramic powders on said first metal [oxide] *ceramic* film.

**15**. A process as claimed in claim **14** wherein steps (c), (d), (e) and (f) are repeated so as to produce a composite [metal oxide] *ceramic* layer at least 10 μm thick.

**16**. A process as claimed in claim **15** wherein said first ceramic powder is silicon carbide and said second ceramic powder is titanium nitride.

**17**. A process as claimed in claim **16** wherein said first and second [organo-metallic] sol gel solutions are the same.

[**18**. A process as claimed in claim **14** wherein said films are crack-free.]

*19. A process as claimed in claim 1, wherein said sol gel solution is organo metallic or a salt.*

*20. A process as claimed in claim 14 wherein said first and second sol gel solutions are organo-metallic or salts.*

*21. A process as claimed in claim 5 wherein said PZT solution is selected from the group consisting of alkoxides, metal salts, carboxylates and ketones.*